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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

THURSDAY, SEPTEMBER 4, 1919.

AN EIGHTEENTH-CENTURY PHYSICIAN.

Dr. John Fothergill and his Friends: Chapters in Eighteenth-century Life. By Dr. R. Hingston Fox. Pp. xxiv+434. (London: Macmillan and Co., Ltd., 1919.) Price 21*s.* net.

MORE than any other period, the eighteenth century is rich in memoirs and biographical history, and from these sources have been obtained most of our facts regarding the mode of life, the characters, and the mental activities of those who were representative of that age. But estimates of the lives and work of physicians have not appeared so frequently, although many medical men in the eighteenth century influenced the social life of their period profoundly enough to merit a biographical memoir.

The life of Dr. John Fothergill is a case in point, and the book under review is a valuable contribution to the biographical history of medicine. Fothergill is fully worthy of the care Dr. Fox has bestowed upon his history, for, in a sense, he was representative of his age and profession. He occupied a respectable, if not a commanding, position in medicine; he was ever ready to promote with his purse and influence the claims of science, and in an age when few paid attention to public health and education he was an energetic and enlightened reformer. Others, notably Lettsom, have essayed the portrait of Fothergill, but we do not remember any memoir in which the character of the great Quaker physician is depicted with more accuracy and skill.

The life of Fothergill may be considered from the point of view of the physician, the man of science, and the philanthropist. In all he played a considerable part, but his precise position as a physician is difficult to describe. He was, it is true, very successful in private practice, and enjoyed an unusually large share of public patronage. From accounts that have been handed down, he appears to have been a shrewd and accurate observer of the clinical phenomena of disease. But to judge from the scanty and hastily composed medical writings left by Fothergill, he does not appear to have been a sagacious scientific thinker, nor has he contributed much to the advance of medicine. He was content to cling to the traditions of the old clinician, and was uninfluenced by the advances that were being made in the study of morbid anatomy as an aid to the diagnosis and treatment of disease. As a physician he belongs to the class of which Richard Warren, Henry Revell Reynolds, and Sir Henry Halford were leaders, but he cannot be assigned a place among the great men who advanced medicine, such as Matthew Baillie, William Prout, and Richard Bright.

Fothergill's position in science was not unlike that of Sir Joseph Banks, whose influence, more than actual scientific work performed, produced a salutary effect on British science in the eighteenth century. Botany interested him keenly, and nearly all the time he could snatch from his medical commitments was devoted to the cultivation of his famous garden of thirty acres at Upton Park, where fifteen gardeners were continually employed. Fothergill's estate at Upton Park was no mere pleasure garden devised for the purpose of social entertainment, but a nursery for the rearing of shrubs and plants brought from all parts of the world by collectors in Fothergill's pay. In this way he was responsible for the introduction of many varieties which can be seen in any garden at the present day.

Besides medicine and botany, Dr. Fox gives a full account of Fothergill's work in education and politics, and his position as a leader of the Society of Friends is dealt with in a temperate and able manner. The book is trustworthy, and should commend itself to those who are interested in the intellectual progress of the eighteenth century.

PHYSICS IN WAR.

Les Applications de la Physique pendant la Guerre. By H. Vigneron. Pp. viii+322. (Paris: Masson et Cie, 1919.) Price 7 francs net.

A BOOK with this title, appearing so soon after the termination of hostilities, could scarcely fail to excite considerable interest. The public in general and people with a scientific turn of mind in particular have been vaguely aware that, during the war, much work has been done in applying scientific principles to military purposes. In this country, as well as in Allied countries, there have been spread, in spite of the censorship, most exaggerated and distorted accounts of the practical results of these experiments. Here, then, in this book, it might have been supposed, would be afforded an opportunity of testing the truth of the rumours which have been current. To a reader in this frame of mind a perusal of the book will be somewhat disappointing. There are no great revelations, and it is a little difficult to see why the French censorship would not allow the author to publish the major portion of the contents during the war as he desired. The important subject of submarine detection and destruction, for example, is dealt with in a couple of pages. There is internal evidence that this does not arise from lack of knowledge on the part of the author, but rather from the operation of the censorship, which can have been removed in a very limited sense only. The author has, no doubt, been seriously handicapped in this way, for the French authorities appear to have been much more strict than our own.

M. Vigneron, in his preface, very properly lays stress on the important part played in the war by those men of science who, before the war, conducted speculative research without thought of the possibility of its practical application, and were forced by circumstances to join hands with the "techniciens," as he calls them. This alliance has produced far-reaching results, and there will be general agreement with the author that it should be fostered and perpetuated. The work of purely scientific workers is very liable to be lost sight of when it becomes absorbed in industry. One feels that M. Vigneron would have been able to do more justice to them had he delayed publication until it was permissible to refer more explicitly to their work. The author is evidently a believer in the practical fruits of pure science, and his advocacy of the methods of the General Electric Co. of Schenectady in this respect is sound.

The first of the seven sections of the present volume deals principally with the applications of optics for military purposes. Of particular interest are the chapters concerning rangefinders, and the many and varied uses of photography in warfare. One misses, however, any adequate reference to modern methods of signalling, such as those with infra-red and ultra-violet light, invented by Prof. R. W. Wood. Sections 2 and 3 are devoted, respectively, to the aerial and submarine aspects of war, and contain many interesting facts and diagrams. There is a long section on artillery and projectiles, containing much information, most of which was probably available before the war. The sixth section, on wireless telegraphy, is shorter than might have been expected, but gives an interesting outline of present methods, including the use of thermionic valves as oscillators and amplifiers. There is merely a mention of wireless telephony, which actually came into considerable practical use during the war. Localisation of foreign materials in the human body, mainly by means of X-rays, forms the subject of the last chapter.

The book is interesting and well written. It is illustrated with many good diagrams and photographic reproductions, which are explained clearly in the text. What is lacking with regard to "secret" developments the author will, we hope, take up in a subsequent volume.

EXPERIMENTAL RESEARCHES ON GLASS.

Experimental Researches Carried Out in the Department of Glass Technology, University of Sheffield. Vol. i., 1917–18. (Reprinted from the Journal of the Society of Glass Technology.) Pp. iii+178. (Sheffield: The University, n.d.)

DR. W. E. S. TURNER is to be congratulated upon the success which has attended the formation of the Department of Glass Technology, Sheffield University, of which he is the head, and of the Society of Glass Technology, of which he is secretary, and in the foundation of which he played a leading part. The results of the experimental researches carried out in the department are now reprinted from the journal of the society, together with certain reports to the council of the university.

Glass is a peculiarly elusive subject for scientific investigation, but neither man of science, technologist, nor practical worker will deny that it is a fascinating one. We know practically nothing about the nature of glass, and in this respect we are much in the position of the metallurgists prior to the introduction of thermal and micrographic methods of investigation. We have as yet no key to the constitution of glass, and this must be sought in the purely scientific study of simple mixtures rather than in the investigation of complex glasses, which experience has proved to be practically useful.

At the beginning of the war very little information was available with regard even to the essential facts relating to scientific glassware, miners' lamps, and electric bulbs, which our glass manufacturers were called upon to supply with the least possible delay. Which was the best of the various brands of beakers and flasks at the moment in everyday use in chemical laboratories? was a question to which only the vaguest answer could be given. As to how these glasses should

anneal so as to withstand the strain of laboratory use nothing was known at all.

The researches which are now republished relate mainly to the practical class of problems. The seven papers on the testing of laboratory glassware contain information which has been of the greatest value to glass manufacturers. They should also be very carefully studied by everyone engaged in analytical work. The attention of chemists and physicists is also directed to some interesting papers relating to the calibration of volumetric apparatus and to blowpipe work.

Experimental work in connection with refractory materials, furnace problems, etc., is also being undertaken, but only preliminary notes on the results are as yet available.

The publication contains an account of the educational activities of the department, which includes a school of instruction in blowpipe work.

M. W. T.

PHYSICAL CHEMISTRY.

(1) *Text-book of Physical Chemistry.* By Prof. A. T. Lincoln. Pp. viii + 547. (London: G. G. Harrap and Co., Ltd., 1918.) Price 12*s.* 6*d.* net.

(2) *Outlines of Theoretical Chemistry.* By Dr. F. H. Getman. Second edition, thoroughly revised and enlarged. Pp. xvi + 539. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1918.) Price 16*s.* 6*d.* net.

IN the matter of text-books, physical chemistry seems to be coming into its own. It is a healthy sign. Not, indeed, that mere numbers of text-books are any trustworthy measure of the growth and vigour of a science, nor is the unrestricted compilation of them to be encouraged, but physical chemistry is a relatively youthful science, and there is still ample room for individual exposition of the subject.

We have before us two general text-books of physical chemistry of moderate size and scope, and it may be said at once that both can be recommended to students who are commencing the subject. In books of this kind the great difficulty for the writer is to know what to exclude, for, of course, much has to be excluded, and no very detailed discussion of any problem is possible. The two books, although of much the same "standard," naturally exhibit their individuality in this respect. There is one point which should not be overlooked: both books are by American authors. It is evident that physical chemistry is taken much more seriously in America than it is in our own country. The fact is that the Americans, like the Germans before them, have realised the fundamental importance of physico-chemical thinking, not only for advance on the theoretical side, but equally so for technical and industrial progress.

(1) Prof. Lincoln's book is well written, and the fundamental principles are clearly developed and explained. Considerable attention is paid to the laboratory side of the subject. There are a few historical references, which give added interest to the text. Without going into detail, it may be said that optical properties are particularly well treated, as is also the general problem of heterogeneous equilibrium—*e.g.* the phase rule and its manifold applications, the principles of fractional distillation, and the solubility relations of three components. (In the last connection a particularly good account is given of the use of the triangular diagram.) There is likewise a fairly comprehensive discussion of colloids, of non-aqueous solutions, and of the ionising power of a solvent. Except in a few sections, only the most elementary mathematics is employed. This makes the book very suitable for those beginning the subject, but, of course, limits its scope. There are a few misprints—*e.g.* Frick for Fick on p. 434—and a rather remarkable statement on p. 378 in connection with hydration, which is not quite what the author intends. The absence of a name index is perhaps a drawback, and the use of the term *heat-tone* as a translation of *Wärmetönung* is to be deprecated.

(2) Dr. Getman's book, which now reaches its second edition, is an excellent exposition of physical chemistry for those commencing the subject. Again only elementary mathematics is used, and, although numerous thermodynamical results are quoted and applied, the author has not attempted any systematic treatment of the principles of thermodynamics which would have taken him beyond the general aim and scope of the book. It may be mentioned that the subject of conduction of electricity through gases is given much more prominence than is usual in a book of this kind. The same thing is true of the subjects radio-activity, atomic structure, polarisation, and photochemistry. The results of modern research have been incorporated in a skilful manner, and the student is frequently referred to original sources for further information. The presentation of the whole subject is consequently very much up to date. Each chapter is furnished with a set of problems which will be of good service in enabling the student to grasp thoroughly the meaning of what he reads.

W. C. McC. LEWIS.

OUR BOOKSHELF.

Text-book on Practical Astronomy. By Prof. George L. Hosmer. Second edition, revised. Pp. ix + 205. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1917.) Price 9*s.* 6*d.* net.

THE professed object of the author was to satisfy the requirements of civil engineering students, who are unlikely to take up a more advanced study of astronomy, and to produce a text-book intermediate between those formally devoted to astronomy and geodesy, and the short chapter on astronomy generally to be met with in works on surveying. By the lucidity of the explanations and the simplicity of the general treatment of the subject, the book seems well adapted to

the needs of such students, and suggests comparison with the work on astronomy by the late Hugh Godfray, which has held the field in our universities for so many years. A good deal of space is wisely devoted to the chapter on time, for the experience of teachers generally will confirm the remark made in the preface that "this subject seems to cause the student more difficulty than any other branch of practical astronomy."

The young student of spherical trigonometry, entering upon the practical solution of triangles, is sometimes a little bewildered by the number and variety of the formulæ put before him for the determination of an angle from three given sides, by means of the halved sine, cosine, tangent, etc. A somewhat novel feature of Prof. Hosmer's work is a short discussion of the conditions under which one of these is to be preferred to the others.

To each chapter is appended a small collection of examples, some numerical, some calculated to test the grasp obtained upon the subject-matter of the chapter. These should be of great assistance to the student. H. B. G.

History of the Theory of Numbers. Vol. i. *Divisibility and Primality.* Publication No. 256. By Prof. L. E. Dickson. Pp. xii+486. (Washington: Carnegie Institution of Washington, 1919.)

THIS work appears to be a chronological encyclopædia rather than a history as that word is usually understood. Prof. Dickson has aimed at giving references to all papers bearing on the subject, and in most cases he has given a summary of the contents.

These papers are so numerous that the need for brevity has forced the author into a style which is often abrupt and occasionally irritating, but the subject-matter will be found invaluable by all who aim at original work in the theory of numbers.

The volume begins with an account of the theory of perfect numbers[1]; these are now of historical interest only, but the quest for all perfect numbers has proved one of the greatest driving forces in the general theory of numbers.

The next topic includes the theorems of Fermat and of Wilson; it is remarkable that the first proof known of the one and the first enunciation of the other are both due to Leibniz.

The section on indices, binomial congruences, and circulating decimals includes a large number of writings of an unusually miscellaneous character, and the reader will find that this source contains much information which has not been easily accessible hitherto.

The most elaborate chapter bears the title "Sum and Number of Divisors"; and this chapter contains many references to the analytical theory of numbers, which has grown so rapidly of late years. On the other hand, recent work on prime number theory is but lightly sketched, and rightly so, inasmuch as the treatise by Landau and subsequent reports have provided all the necessary material.

[1] The Greeks called a number *perfect* if the number happens to be equal to the sum of its divisors. For example, we have

$$6=1+2+3,$$
$$28=1+2+4+7+14.$$

Physical Laboratory Experiments for Engineering Students. By Prof. Samuel Sheldon and Prof. Erich Hausmann. Part i. *Mechanics, Sound, Heat, and Light.* Pp. v+134. (London: Constable and Co., Ltd., 1919.) Price 6*s.* net.

THIS book, prepared for use in the Polytechnic Institute of Brooklyn, is suitable for candidates for engineering degrees who have already pursued laboratory courses in physics. "Each experiment has been chosen because of its close connection with engineering work, and in many cases the theoretical result may be calculated from the constants of the apparatus with which that result obtained by experiment may readily be compared. As these two results approach to an equality the student gains confidence in the apparatus, confidence in the theory, and confidence in himself." This is well said. There can be no doubt that many students lose not only confidence but also interest in physics when they find that owing to inefficient apparatus results of reasonable accuracy cannot be obtained. The experiments here described are well selected, and as apparatus of engineering design has been chosen, the equipment with ordinary care in use should continue to give sufficient accuracy. Special mention may be made of the apparatus for the study of the harmonic motion of a rotating system, which appears to be unknown to British instrument makers. The book is printed on good paper, and is well illustrated.

H. S. A.

The North Riding of Yorkshire. By Capt. W. J. Weston. Pp. viii+161. (Cambridge: At the University Press, 1919.) Price 2*s.* 6*d.* net.

IN view of the time which has elapsed since the greater proportion of these well-known county geographies were issued, one had almost feared that the greatest county had been overlooked. It is now apparent that three volumes will be issued for Yorkshire, one for each Riding, and the first of these, dealing with the North Riding, has just appeared. As we are fairly familiar with all that have previously been published, it is a pleasure to be able to state that this is one of the best; the author seems to have had a better grasp of the object of the work he has had in hand, resulting in a volume which is much more a geography than a guide-book. The illustrations are numerous and well chosen; misprints, as usual, are few—which makes that in the word "Montreal" on p. 58 all the more glaring. The only statement we cannot agree with is in reference to the "raised beach" at Saltburn, which is now known to be a "kitchen midden." The colouring of the geological map at the end, for which the author is not responsible, does not seem quite so successful as with the maps in the earlier volumes.

T. S.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can be undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Explosion at Bailleul.

THE reports referred to in NATURE of August 28 (p. 511) of the effects observed at Denmark Hill, Norwich, and elsewhere by the explosion of a munition dump at Bailleul at 1.10 p.m. G.M.T. on August 8 suggest that these effects were due mainly to earth tremors caused by the explosion, since the rattling of windows, extending in one case throughout two and a half minutes, is alone mentioned. Here, however, at Harpenden, and also at Luton and Stevenage, an actual sound of a very marked character was heard. The first impression produced in my own case was that a ceiling or heavy picture had fallen in one of the upper rooms, and I at once went round the house to ascertain if that was the case. Everyone in the immediate neighbourhood seems to have heard the noise equally clearly, and it was very generally attributed at first to an explosion of a factory or munition dump four to six miles distant. The noise, which may have lasted two seconds, was preceded by a lesser sound, or perhaps only a tremor, which made one anticipate that something was coming. This, of course, is usual in the case of explosions. SPENCER PICKERING.

Harpenden, Herts.

British Well-worms.

FROM facts which have recently come to light, I am led to believe that there is a good deal yet to be learned about the Oligochæts which occur in our wells and water-supplies. It is now many years since I directed attention to the occurrence of *Pachydrilus* (*Lumbricillus*) *subterraneus*, Vejd., in tap-water and elsewhere. The first well-worm to be discovered in the country was named by me *Diachaeta curvisetosa*. It was afterwards discovered that it belonged to the Haplotaxidæ, and is now known as *Haplotaxis curvisetosa*, Friend. In spite of Michaelsen's conclusion to the contrary, this is quite a distinct worm from *Haplotaxis gordioides*, which I have found in this country. Another well-worm, the description of which may be expected to appear shortly in the Quarterly Journal of the Microscopical Society, is *Anagaster fontinalis*, Friend, which has been found in East Anglia. I have notes of other species of worms found in water, including Rhynchelmis, taken in Hampshire, and some which have not been named for want of perfect material. As I am now engaged on the preparation of a monograph of British Oligochæts, it seems very desirable that our knowledge of this branch of the subject should be perfected, and it would be esteemed a great favour if persons who find worms in their wells, pumps, taps, and water-supply would send me the same for identification and record. HILDERIC FRIEND.

"Cathay," Solihull, August 29.

THE PROTECTION OF OUR "KEY" INDUSTRIES.

IT has long been foreseen that one of the immediate consequences of peace would be to subject this country to a flood of manufactured articles from Germany. It has been known for some time past that German manufacturers were preparing, by every means in their power, to recover and retain their former hold on our home markets. They were steadily accumulating stocks to be "dumped" in Great Britain on the first possible opportunity. It was a policy of despair, but it was the only policy open to them. The salvation of certain of their industries depended on their being able to thwart, by fair means or foul, the expansion of such of these industries as the exigencies of war had called into existence in this country. Our national welfare, indeed, was bound up in these industries. The country was quick to recognise their importance, and the Government responded to public pressure by the steps it took to foster their initiation and development. Some of these steps were of paramount necessity as war measures, but they had a still wider significance. With the outbreak of war the Empire realised, as never before, that it had in large measure failed to perceive the full importance of the bearing of science upon industry. Owing to a variety of causes on which it is no longer necessary to dwell, we had allowed our chief enemy to take over and gradually to obtain almost exclusive possession of certain "key" industries depending upon the applications of physical science, such as the manufacture of synthetic dyestuffs and drugs, analytical reagents and other chemical products, optical glass and instruments, electrical apparatus and magnetos, etc. We had become wholly dependent upon Germany for a large number of articles comprised under these categories which are absolutely essential to the prosecution of war under modern conditions. It speaks volumes for the innate genius of our race that our men of science and our manufacturers, when thus confronted with a national emergency, should have responded as they did to the country's call. We have not only triumphed over difficulties which at one time seemed well-nigh insuperable, but, as is well known, we have also in many cases bettered the example of our enemies, and certain of our manufactured articles have reached a pitch of excellence which Germany never attained.

This pre-eminence—the fruit of so much anxiety and toil—ought surely to remain with us. Our legislators would be false to their trust if they allowed political expediency and party faction to rob the country of the position it has now gained through the circumstances and fortune of a war which was thrust upon it. The common sense of the nation demands that those industries which we have been compelled by the necessities of this war to establish by a great expenditure of effort and capital, and which are everywhere recognised as no less important in times of peace, should be preserved and fostered. "Never again" has become a watchword. But, even apart from any question of security, the country would be blind to its opportunity if it allowed these "key" industries to fall back into their pre-war condition. The few years of their existence are, however, too short to have brought them into a position of stability. There is an enormous amount of leeway to make up. One

cannot expect in four years to reach the position which it has taken forty years of organisation, skill, and enterprise on the part of Germany to secure.

The country, therefore, will welcome the steps which the Board of Trade has taken, in conformity with the Prime Minister's recent statement in Parliament, to protect goods manufactured in Great Britain and Ireland against "dumping," and to check any flood of imports (for instance, from Germany) that might arise from a collapse of exchange so disproportionate to costs of production in the country of origin as to enable sales to take place in this country at prices altogether below costs of production here. It is, of course, too much to expect that this action will pass unchallenged. There is a school of politicians in this country who, like the Bourbons, learn nothing and forget nothing. They are a decreasing faction, it is true, and recent events have tended to submerge the survivors. In a few years they will be as extinct as the dodo. It is a significant fact that the fiscal tenets of the Manchester School are never cherished by a real democracy.

Pending the legislation which is to be introduced into Parliament when it reassembles in the autumn, the Board of Trade under the powers conferred upon it will, as from September 1, 1919, prohibit the importation into the United Kingdom of synthetic dyestuffs, drugs, and "intermediates" needed in their manufacture; also synthetic flavourings and perfumes, synthetic photographic chemicals, and a considerable number of inorganic products and medicaments of which the manufacture had to be started in this country in consequence of the war, and which German manufacturers had intended to "dump" into this country as soon as trade relations were re-established.

In addition to the chemical products enumerated in the schedule of the proclamation, the Board of Trade is taking steps to protect the new industries dealing with optical glass, scientific glassware, laboratory porcelain, and a number of products of which the Germans by various means, some of them of a very dubious character, had secured a monopoly. This action will, no doubt, occasion great perturbation in the Teutonic mind. It may even amount to dismay. The enemy had probably calculated, and as usual miscalculated, on prejudices which occasionally seem to obscure the recognition of our true interests as a trading community. "'Tis sport to have the engineer hoist with his own petar."

THE ORGANISATION OF RESEARCH.

PART of the scheme devised by the Department of Scientific and Industrial Research for the administration of the funds placed at its disposal by Parliament was the formation of associations among groups of manufacturers, and a conference was held on July 29 of representatives of the associations already formed for the purpose of discussing some of the many problems which have presented themselves in connection with their work.

In the absence of Mr. H. A. L. Fisher, President of the Board of Education, the chair was taken by Sir William McCormick, chairman of the Advisory Council. Sir Frank Heath, secretary of the Department of Scientific and Industrial Research, was also present, besides some sixty to seventy representatives. A great diversity of subjects was thus represented, though some, especially the great chemical industries, were conspicuously unrepresented.

The meeting was informed that nine research associations were in operation, eight more have been approved and are only waiting the licence of the Board of Trade, while twelve others are under discussion. So much having been accomplished in the three years which have elapsed since the idea originated, it may be assumed that a general approval has been given to the scheme by the industrial world, but the initial difficulties are far from being overcome as yet.

Among the subjects discussed at the conference the first was the formation of a records bureau, and the second the difficult and important one of the conditions of employment of research workers engaged by the associations. Other questions related to co-operation among the associations, and the amount and method of assessment of the subscriptions to be paid by the associated firms in addition to the subsidy from departmental funds.

The formation of a bureau of information and for the recording of results secured by research is a matter of the utmost importance. In the first place it is proposed that its task should consist in storing up the results of work done by the associations, but even this will be found very expensive and not free from difficulties, owing to the views prevalent in some quarters as to secrecy. The associations require access to information of every kind, and apparently the representatives assembled have something to learn with regard to the existing sources of much of the information they require, for throughout the discussion no reference was made to the magnificent journals, containing both original papers and abstracts, issued by some of the British and American engineering and chemical societies. It seems to be recognised that a large number of reference libraries will have to be established, especially in the neighbourhood of great centres of industry; but it ought also to be understood that every association will require a library stored with works of reference, and especially journals cognisant of the subjects it represents; indeed, every works which has a laboratory for research must be similarly provided. All this represents a large outlay of money, the amount of which can scarcely be calculated as yet.

The other serious point under discussion concerned the interests of the separate associations, and perhaps more particularly those of the in-

dividual research workers. And here it would be well to consider the difference between discovery and invention. The former is usually the result of protracted inquiry by highly skilled and highly educated workers, while invention may, and does often, result from the recognition of a need or opportunity for improvement in a machine or process by a mere workman, ignorant of science in a general sense, but whom long experience in some one industry has led to realise the technical difficulties peculiar to the work in which he has been engaged. The question before the conference was how to estimate the value of the services rendered by a successful employee and the right way to reward them. This is a very difficult problem. Any system of bonuses would be for various reasons undesirable and perhaps unfair. There was agreement that the scale of remuneration must be liberal, in order, for one thing, that the man so employed may be free from anxieties as to his own future. But it is becoming clear to everyone that if industry is to enjoy the advantage of engaging the best brains of the nation this kind of calling must be made attractive to the rising young men and women. At present, as pointed out by the chairman, the new research associations are finding that there are not sufficient scientific workers to go round.

THE BOURNEMOUTH MEETING OF THE BRITISH ASSOCIATION.

THE success of the meeting of the British Association, which opens in Bournemouth on September 9, should be a foregone conclusion if one may judge by its appeal to the imagination. It may be said that a scientific history of the war will be presented. Commencing with the inaugural address of the president (the Hon. Sir Charles A. Parsons, K.C.B.), which will deal with "Engineering and the War," throughout the week the invaluable war-work of men of science, which played so magnificent a part in our victory, will be the subject of a great variety of lectures and debates. Secrets which have hitherto been jealously preserved will be made public, and it should be possible after the meeting to estimate as never before the enormous importance of science in modern military operations.

Apart from questions of war, a large proportion of the papers and discussions will be closely in touch with the problems and activities of the Empire to-day. Education, citizenship, and economic and industrial difficulties will all be prominent features of the programme.

There is every reason, therefore, to believe that the meeting will be of unique interest and importance. Whether it will be an equal success in point of numbers in attendance is less certain. The amount of interest shown locally in the proceedings cannot at the time of writing be said to have come up to expectations. This comparative lack of enthusiasm is not, however, surprising in a town of so many and diverse distractions. The number of applications for associateship and membership is at present much smaller than anticipated, but in the opinion of those competent to judge the eleventh hour will bring a marked improvement in this direction.

One of the greatest problems which the local executive committee has had to face has been that of finding accommodation for visitors. A popular seaside resort in September inevitably presents extraordinary difficulties in this respect. Great efforts have been made to deal with the situation, and considerable public spirit has been displayed by hotel-keepers and others in helping the committee in its task.

The local preparations for the meeting are well in hand. The work of adapting the Municipal College to the needs of the Association is practically complete, and better accommodation has probably never been provided.

THE PROTECTION OF WILD BIRDS.

THE Report of the Departmental Committee on the Protection of Wild Birds, which has just been issued, after a considerable delay due to war conditions, marks an important step towards the proper and efficient control of British bird-life, which has been subject to the varying and complicated regulations of a long series of legislative enactments. The report foreshadows unified and simplified lines of regulation which, if adopted in law, ought to make the protection of wild birds not only more practicable, but also more effective. Of the fresh suggestions made by the expert Departmental Committee, to which the thanks of all naturalists are due, the most far-reaching is that regarding the formation of a permanent Ornithological Advisory Committee, which would sit in London and not only advise the Central Authority on all ornithological questions, but also collect information and control investigations bearing upon the activities and status of wild birds. It is astounding to learn, though it is undoubtedly on a par with the official attitude towards science, that the Wild Birds Protection Acts have been administered without any expert ornithological assistance, except in the case of Scotland. Even there the matter of advice seems to have been, so to speak, behind the scenes, for there is no evidence of public acknowledgment of this highly technical information and advice.

Of many suggested improvements upon the old laws, mention can only be made of a few. All birds are recommended for protection during the breeding season, from May 1 to September 1, subject to the right of the owner or occupier, but even this exception is abolished in the case of scheduled birds, which, in Schedule A, including more than fifty species, are absolutely protected during the breeding season, and in Schedule B, including about twenty-seven species, are absolutely protected throughout the year. The unifying of the schedules for the protection of both birds and eggs is a vast improvement upon the present

independence of the two groups, which has led only to confusion; while the protection of all birds and eggs on Sundays and the licensing of bird-catchers and bird-dealers are new and valuable suggestions. It must be the hope of the British naturalist that as soon as possible these recommendations will be adopted and become the law of the land.

NOTES.

WE are informed that the council of the Royal Society has nominated representative committees to deal with national questions connected with the international unions which it is intended to form under the International Research Council. The committee for astronomy will consist of the Astronomers Royal for England, Scotland, and Ireland, the Superintendent of the Nautical Almanac, six members nominated by the Royal Society, six members nominated by the Royal Astronomical Society, two members nominated by the Royal Society of Edinburgh, two members appointed by the Royal Irish Academy, and two members appointed by the British Astronomical Association. The committee for geodesy and geophysics will consist of the Astronomers Royal, the Director of the Meteorological Office, the Director-General of the Ordnance Survey, the Hydrographer of the Navy, two representatives of the Royal Society of Edinburgh, two representatives of the Royal Irish Academy, two members nominated by the British Association, and two members nominated by the Royal Society. Since their formation these committees have advised the council of the Royal Society on the formation of the international unions in their respective subjects, and nominated the delegates to the recent meeting at Brussels. The Federated Council for Pure and Applied Chemistry was also recognised as the national committee on that subject. As regards other subjects, similar committees will no doubt be established, but, no definite proposals having been submitted by any country, no action has hitherto been taken, and the powers of the delegates attending the meeting at the invitation of the council of the Royal Society were limited to the obtaining of information with regard to the views of other countries concerning the establishment of international unions. The recommendations made only express the personal views of delegates attending the conference, and will, no doubt, be submitted to the proper authorities before any action is taken.

AT the death of Prof. Milne in 1913 the British Association Seismological Committee decided to maintain the work at Shide, both the actual observations with seismographs and the collation of results from the Milne stations scattered over the globe. The seismographs were mounted in a disused stable; the clerical and computational work was carried on in an annexe built to the dwelling-house by the liberality of the late Mr. M. H. Gray. Mr. J. H. Burgess and Mr. S. W. Pring, two residents in the neighbourhood who had worked with Prof. Milne, were able to devote part of their time to the work under the general superintendence of the committee. The war steadily rendered this arrangement more and more difficult; Mr Burgess and Mr. Pring both ultimately left Shide, and early in the present year Mrs. Milne, from whom the observatory had been rented by the committee, announced her desire to sell the house, including the observatory, and to return to her home in Japan. In anticipation of the difficulties becoming acute, preparations had been made for transferring the work to Oxford. A seismograph was mounted last October in the basement of the Clarendon Laboratory, where Prof. C. V. Boys made his well-known gravity determination. Permission to make trial of this site was kindly granted by Mr. James Walker, then in charge, and has since been confirmed by Prof. F. A. Lindemann. The results have been eminently satisfactory, and there is ample room for the other component. The arrangements for housing the Milne seismological library (definitely left in his will to the British Association Committee) and the computational work are not yet finally settled, but no serious difficulty is anticipated in finding a solution. The arrangements are necessarily of a provisional type at this moment, and liable to be modified by future events, such as the possible establishment of a geophysical institute at Cambridge, and the action ultimately taken by the Seismological Section of the International Union of Geodesy and Geophysics recently established at Brussels. The Union itself was fully constituted, but the Seismological Section was suspended until some legal formalities connected with the extinction of the former International Seismological Association have been completed.

WE regret to announce the death on September 2, at seventy-five years of age, of Prof. Alexander Macalister, F.R.S., professor of anatomy in the University of Cambridge.

DR. C. A. MERCIER, physician for mental diseases to Charing Cross Hospital, and a distinguished authority upon mental diseases and related subjects, died on September 2 at sixty-seven years of age.

THE Lord President of the Council has appointed Prof. J. E. Petavel, F.R.S., to be director of the National Physical Laboratory in succession to Sir Richard Glazebrook, C.B., F.R.S., who retires on reaching the age-limit on September 18 next. Prof. Petavel is professor of engineering and director of the Whitworth Laboratory in the University of Manchester. He is a member of the Advisory Committee for Aeronautics of the Air Ministry.

THE committee of the Wireless Society of London met on July 24, under the presidency of Mr. Alan A. Campbell-Swinton, with a view to an early resumption of activities. The hon. secretary, Mr. R. H. Klein, having resigned, and been elected an acting vice-president, Mr. Leslie McMichael, of 30 West End Lane, West Hampstead, N.W.6, has been elected hon. secretary, and to him all communications should be addressed. The society is open to all those interested in the study and furtherance of wireless telegraphy, amateur or professional.

THE Edward Longstreth medal of the Franklin Institute, Philadelphia, has been awarded to Mr. J. J. Skinner, of the Bureau of Plant Industry of the U.S. Department of Agriculture, for his papers on "Soil Aldehydes," concerning which the committee reported: "These papers present the results of scientific study of a new class of deleterious soil constituents, clearly described and effectively illustrated, the whole forming a valuable contribution to the science of agricultural chemistry, and one of marked practical importance."

FROM the Proceedings of the Institute of Chemistry we note that the preparation of an account of the services of British chemists during the war is under consideration. A synopsis of the possible contents of a book on the subject has been drawn up, and preliminary arrangements have been entered into with publishers. Such a work may be made both interesting

and valuable, and it is to be hoped that the project will be worthily carried out. All chemists who are in a position to assist in the matter are invited to communicate with the registrar of the institute.

Two important geological collections of more than local interest have recently been acquired by the Hull Municipal Museum, viz. the Drake and Bower collections. The first was formed by the late H. C. Drake, F.G.S., who spent many years in the Scarborough district, and also collected largely among the saurian and other vertebrate remains of the Oxford Clay in the Peterborough area. The other collection was formed by the Rev. C. R. Bower. Many of the specimens are described and some figured in his paper on "The Zones of the Lower Chalk of Lincolnshire" in the Proceedings of the Geological Association for 1918. This collection consists of more than a thousand excellently cleaned Chalk fossils, carefully labelled and localised, including many of those which have been figured in his paper, as well as one of the two known examples of *Actinocamax boweri*, the other specimen being in the British Museum. The collections are largely from the Lower Chalk of Lincolnshire and the Chalk of Yorkshire, and there is an interesting series from the Upper Cretaceous of Dover, Folkestone, Kent, and Norfolk.

THERE is no denying the value of intelligent propaganda for increasing business and cultural relations between various nations. As an example of the right kind of propaganda we would mention the Bulletin of the Pan-American Union, published in English, Spanish, Portuguese, and French. This magazine contains authoritative articles on North and South American activities, most of them being splendidly illustrated.

THE *Bulletin officiel de la Foire de Lyon*, of which two recent issues are to hand, is the outcome of the first Lyons Fair, and its object is to keep manufacturers and others in touch with the development of these fairs in France and other countries. In this connection it is interesting to note that the next Lyons Fair will be held on October 1–15 next. The previous fair was a great success, but it is hoped that British manufacturers will be more adequately represented at the forthcoming fair. American competition in France, especially in matters engineering, is very keen, and it is up to British enterprise to see that no trouble is spared in order that French traders, engineers, consumers of scientific products, etc., may know exactly what Britain is able to offer them.

IN the current issue of the *Quarterly Review* Sir Lynden Macassey discusses very ably "The Economic Future of Women in Industry." The author is specially well qualified for his task, as he was a member of the War Cabinet Committee which made extensive inquiries into the subject, and during the war he acted as arbitrator in innumerable labour disputes. He rightly states that the public in general but little appreciates the enormous latent and unutilised capacities for production possessed by the women of the nation. He points out that between 1914 and 1918 more than 700,000 women directly replaced men in industry, and did work customarily done by men. On repetition work, which was such a pronounced feature of war-time employment, women often proved superior to men, as they do not suffer from the monotony to which men are so susceptible. On the other hand, they are not man's equal in skilled work, and because of their greatly inferior physical strength they cannot replace him in the heavier types of industry. As regards the future, there ought to be no trade union rules which debar women from any employment which is commensurate with their industrial qualifications, but women must not be allowed to undercut and displace men. They must come in as additional workers to accelerate the increased productivity which is such a crying need of the present day. Sir Lynden Macassey approves the conclusion of the Committee that women on piece-rates must, as compared with men, receive "equal pay for equal work," but both he and they have missed the fallacy involved in such a contention. If the average woman has as large an output as the average man she is entitled to equal pay, but not otherwise. In most industries the cost of establishment and machinery is far higher than the cost of wages, and if, for instance, the woman produces only four-fifths as much as the man, it would not be reasonable for her employer to pay her four-fifths his wages. Probably he could not afford to give her even three-fifths as much.

AMONG the pamphlets on reconstruction problems recently published by H.M. Stationery Office is one relating to Industrial Research (No. 36, price 2*d*.), which ought to be read by the public, whether directly concerned with industry or not. It contains in fewer than thirty pages a very instructive sketch of the position in the past, and of what has already been accomplished in the way of instituting and organising new fields of research and indicating what may be hoped for in the future. At the present time there can be few people who are not convinced of the necessity for research in its relation to industry, but it was not always so. Looking back only forty years or thereabouts, it may be asserted that at that time practically no provision was made by manufacturers for improvements in their several industries. Among the earliest of the manufacturers of iron and steel to carry on research were Sir Isaac Lowthian Bell and Sir Bernard Samuelson, but in other directions there was practically nothing to be seen in the way of research except—to their credit be it said—among the great brewers, who set a fine example to the rest of the world in the way they proceeded to apply the results of Pasteur's discoveries. In connection with agriculture the work of Sir John Lawes at Rothamsted, aided through many years by Sir Henry Gilbert, represented an advance of incalculable importance. Besides showing what can be done, their work seems to illustrate the fact that research, and hence discovery, have in the past depended chiefly on the enthusiasm of the individual man of science. It remains to be seen how far this will continue to be the case. This certainly seems probable in connection with pure science, but we have yet to learn the extent to which organisation will facilitate the discovery of new facts and principles, though there can be no doubt as to the more abundant results which must accrue from the application of such facts and principles to practical purposes. It is now clear that as there must be more scientific work done, there must be a larger number of properly trained scientific workers; and one of the first duties of the State will be to see that the universities and places of higher instruction are provided with the means of giving the instruction needed, and that conditions are so improved as to give the encouragement wanted to induce the most capable among the rising generation to pursue science as a career. It is rightly pointed out in the pamphlet that working-class opinion especially should be made aware of the vital importance of research.

THE *Mexican Review* of July describes, with photographs, a remarkable series of stone and terra-cotta remains discovered in the neighbourhood of the

city of Mexico by Prof. W. Niven. The writer supposes that these remains, rude in design and workmanship in comparison with those from the upper strata, represent Chinese, Egyptian, and negro faces, buried under deposits of lava from volcanoes in prehistoric times. Besides these were found beads of jade, "presumably from China," and seals, "in imitation, or perhaps precedence, of like objects found in the Babylonian and other ruins of the Far East." It is to be hoped that these articles will soon be examined by experts. If these statements can be verified, they will furnish valuable evidence in support of the conclusions of Prof. Elliot Smith and other advocates of the theory of culture transmission.

We have received No. 14 of the Journal of the East Africa and Uganda Natural History Society, written by residents in the African tropics, but printed in this country and published by Messrs. Longmans and Co. The issue contains descriptive articles on such subjects as the transmission of human and animal diseases by blood-sucking insects, and a number of short original notes on the habits of various African animals, such as baboons, crocodiles, and the aardvark.

The report on Scottish ornithology for 1918 by the Misses Rintoul and Baxter, which appears in the July–August issue of the *Scottish Naturalist*, is an excellent and comprehensive compilation, and affords much information on a variety of subjects associated with bird-life. Though the necessary field-work during the year was carried out under greater disadvantages than ever before, yet the contributions of the numerous recorders relate to observations on no fewer than 184 species. No new birds were added to the avifauna, and the list of uncommon alien visitors is a short one, but a number of species are mentioned as appearing in counties in which they were previously unknown. The influence of weather on bird-life during the year, the results of "ringing," and notes on plumage, food, habits, etc., are also given. The final section of the report deals with the migratory movements of both native species and birds of passage. The observations, which are concisely treated, have been made throughout the mainland and at coastal and insular stations from the Muckle Flugga—the northernmost outpost of the British Isles—to the Tweed and the Solway. The data relate to the comings and goings of no fewer than 160 species.

The *Times* of August 18 contained an interesting article on the little owl as a danger to poultry and game. This bird was not originally a native of the British Isles, but was introduced into several parts of England in some numbers about a quarter of a century ago by several well-known ornithologists, who cannot have been aware of its harmful proclivities. Apart, however, from its vices, it is an attractive little bird. Since its introduction it has increased very rapidly, and is now widely distributed over England, and some have found their way into Wales, Scotland, and Ireland. Wherever it has established itself it has become a pest to poultry-keepers and game-preservers owing to the havoc it makes among the chicks. It also destroys great numbers of small birds up to the size of a blackbird. Although the little owl's record is, in the main, a black one, and far outweighs anything that can be placed to its credit, yet it must be admitted that it destroys large numbers of small rodents, such as field-voles, as well as beetles and other insects, and thus renders some service to the agriculturist. The article is evidently based upon a wide knowledge of the bird, and affords much information on other aspects of its life-history.

In the Bulletin of the Imperial Institute (vol. xvii., 1919, pp. 40–95) there is an excellent detailed account of the production and consumption of cocoa, chiefly in the different countries of the Empire, and showing very clearly the disparities between them in various parts of the world. The United States, using 66,500 tons in 1913, is the greatest consumer, whilst its production is negligible. The United Kingdom in 1913 consumed about 28,000 tons, a great deal of which was imported from foreign countries, while the Empire produced about 88,000 tons, the bulk of which had to go abroad for consumption. In 1917, owing chiefly to the enormous increase of cultivation on the Gold Coast and elsewhere in West Africa, the production increased to 142,800 tons. No attempt is made to describe the methods of preparation in use in the different Colonies, and one is left to infer, when noting the comparative values of cocoa given in various places, that in general they leave a good deal to be desired. The cocoa situation at present evidently turns upon the crop of West Africa, and if that country continues to turn out such enormous quantities of an inferior article, trouble is certain to ensue. The great desideratum at the moment is to increase the consumption of this most valuable food and palatable drink, and it is difficult to do so if the quality be but poor. Cocoa, it is well known, can be produced with less trouble than many other tropical crops, especially if some of the poorer Forastero varieties be employed, but to prepare it of really good quality—as, for instance, it is prepared by the English planters of Ceylon—involves much trouble and the use of better varieties. Nothing less than this, however, will save the market from being glutted with inferior brands of cocoa.

Under the title "Gossypium in Pre-Linnæan Literature" (Botanical Memoirs No. 2, Oxford University Press), H. J. Denham traces the literature of cotton-yielding plants from the earliest writers to the time of Linnæus. The earliest reference to the use of cotton for textiles is by Herodotus, who mentions trees in India "the fruit whereof is a wool" of which the natives make clothes. The first reference in botanical literature is by Theophrastus (370–285 B.C.), who speaks of a wool-bearing tree on the Island of Tylos (in the Persian Gulf). Pliny (A.D. 23–79) repeats the information, but quotes the name "Gossypinum" for the trees. Between the classical writers and the herbalists who followed the Renaissance no botanical mention of cotton occurs. By this time the plant was well known around the Mediterranean. The first figure of Gossypium in European literature would seem to be in the "Herbal" of Dorstenius (1540) under the name of Bombax—apparently a conventional drawing of the Asiatic species, *Gossypium herbaceum*. A better figure of this plant was given by Fuchs ("Historia Stirpium," 1542), with a detailed account; but that of Matthioli ("Kreutterbuch," 1563) is more satisfactory. Cæsalpino (1583) was the first botanist to indicate the relationship of the plant to the mallows. In 1592 Prosper Alpinus, in his account of the flora of Egypt, describes and figures another species, *G. arboreum*, a small perennial shrub, a native of northern Africa. Columbus and the early explorers had found cotton in cultivation in the New World, and in 1651 Hernandez figured a Mexican species, *G. mexicanum*, the possible parent of the upland cottons. The botanical history of cotton in the later pre-Linnæan writers is mainly a record of the attempt to simplify the confusion created by the description of different species under the same headings, as, for instance, by Plukenet ("Phytographia," 1691),

though fortunately in this case the specimens from which the plates were drawn are preserved in the Sloane Herbarium in the British Museum. Linnæus (1753) defined four species, the two Old World forms and two American, one of the latter being *G. barbadense*, presumably the parent of the "Sea Island" cotton.

METEOROLOGICAL Office Circulars Nos. 37 and 38, issued July 1 and August 1 respectively, deal with current official notices. Reference is made in the July circular to Professional Notes No. 7—"The Climate of North-West Russia," which was prepared for the use of the British forces acting on the Murman coast. The general climate is discussed for the district extending from the Arctic Ocean on the north to Petrograd and the Gulf of Finland on the south, and from the Swedish frontier on the west to 45° east on the east. It deals with the dates of the thawing and freezing of the rivers. The temperature of the upper air is discussed, and other meteorological information is given. Upper-air temperatures in the north-east of France are given for the end of April last as being of interest in connection with the heavy snowfall over England on April 27. The upper air was abnormally cold. The August circular has an obituary notice of Lord Rayleigh.

THE very effective hardening solution for gelatine negatives that Messrs. Ilford, Ltd., recently introduced is applied as a preliminary bath, before development, and enables development, etc., to be carried on at as high a temperature as 110° F. without any cooling being necessary. In the specification of the patent granted to Messrs. Agnew and Renwick, both of Messrs. Ilford, Ltd. (see *British Journal of Photography*, August 8), it is stated that the formaldehyde, which is the real hardening agent, is mixed with a salt of the class which tends to restrict the swelling of dry gelatine in water and raise its melting-point, so that even though the bath may be at as high a temperature as 110° F., the gelatine has no opportunity of melting before it is hardened by the formaline. This class of salts includes acetates, tartrates, citrates, oxalates, sulphates, phosphates, chromates, bicarbonates, and borates. Example formulæ are given, using sodium sulphate and ordinary sodium phosphate.

A PAMPHLET issued by the Optical Pyrometer Syndicate, of Audrey House, Ely Place, E.C.1, contains some notes on optical pyrometers in general, and a special account of the "wedge" pyrometer and its uses. The early form of this instrument was described in NATURE for July 22, 1915, the principle relied upon being the complete extinction of the source of light by means of a wedge of dark glass interposed between the eye and the source, the temperature being deduced from the thickness of dark glass needed to secure extinction. It is claimed that not only can concordant results be obtained by a single observer trained to the use of the instrument, but also that separate observers may obtain readings agreeing to within 20° C. at 1500° C. One of the disadvantages of all optical pyrometers is that the personal judgment of the operator must be relied upon, either in matching tints or in producing total extinction, and for these purposes all eyes are not equally sensitive. In view of the great increase in the use of optical pyrometers, an impartial investigation of the various types from this point of view would be an advantage, due regard being paid to the type of observer employed in workshops. If the agreement in readings claimed for the "wedge" pyrometer should prove to be general for all types of observer, this instrument ought to be very useful, and its simple construction a recommendation for industrial purposes.

ACCORDING to an editorial note in the *Scientific American* for July 19, the romance of invention is to be illustrated in a series of articles on Americans who have produced inventions of the first rank which have proved financially successful. The whole record shows that the ability to invent and the ability to make a commercial success of an invention are seldom combined in one man, and the editor almost regards them as mutually exclusive. The first article of the series deals with the telephone. Dr. Graham Bell, who is now seventy-two, invented the telephone in 1876. He himself says he is not a business man and that his interest in the commercial side of an invention is small. He was, however, in the early days of the telephone so fortunate as to be associated with able business men who not only made it a commercial success, but also safeguarded the inventor's interests in such a way that its success was of benefit to him. It is not desirable that so large a proportion of those who invent or discover something of the greatest value to humanity should see the reward pass to others while they themselves get little or no recognition from their country or the world at large.

THE Journal of the British Science Guild for July contains a summary of the proceedings of various committees, including those dealing with education and with the metric system, and an account of the thirteenth annual meeting held on June 17. The education committee emphasises the unfavourable position of this country, as regards both the financial position of institutions for higher education and the number of students of university grade, in comparison with other countries. A detailed report on "Industrial Research and the Supply of Trained Scientific Workers" has been sent to the Prime Minister, to the President of the Board of Education, and to universities and similar educational bodies. Special attention has also been devoted by the guild to the organisation of research in relation to fisheries, and importance is attached to the establishment of an institute and museum of oceanography, similar to those in existence in Berlin and in contemplation in Denmark. The attention of the Government has also been directed to the importance of establishing a strong optical industry in this country. A measure recommended is the introduction of certificates of origin of optical goods as a safeguard against fraudulent competition. The report of the thirteenth annual meeting includes the addresses delivered on that occasion by Major-Gen. Seely, Lord Sydenham, and Sir J. J. Thomson. The journal also contains an appreciation of the late Sir Boverton Redwood by Prof. F. Clowes.

Mr. Edward Arnold announces a new series entitled The Modern Educator's Library. The general editor is Prof. A. A. Cock, and the aim is to present the considered views of teachers of wide experience and ability upon the changes in method involved in the development in educational theory and practice, and upon the problems as yet unsolved. The first volume of the series (by Prof. T. Percy Nunn) will form an introduction to it, and will deal with the fundamental questions which lie at the root of educational inquiry. It will be entitled "Education: Its Data and First Principles." Succeeding volumes will be "Moral and Religious Education," Dr. Sophie Bryant; "The Teaching of Modern Foreign Languages in School and University," Prof. H. G. Atkins and H. L. Hutton; and "The Child under Eight," E. R. Murray and H. Brown Smith. Other books announced by the same publisher are:—"A Physician

in France," Sir Wilmot Herringham; "The Struggle in the Air, 1914–18," Major C. C. Turner; "Memories of the Months," Sir Herbert Maxwell, Bart., sixth series; "Gardens: Their Form and Design," Viscountess Wolseley; and "Modern Roads," H. P. Boulnois. *Messrs. Thomas Murby and Co.* announce:—"An Introduction to Palæontology," Dr. A. Morley Davies; "Petrographic Methods and Calculations," Dr. A. Holmes; and "A Nomenclature of Petrology," Dr. A. Holmes. *Messrs. Scott, Greenwood, and Son* have ready for publication the second English edition of "Chemical Reagents: Their Uses, Methods of Testing for Purity, and Commercial Varieties," Dr. C. Krauch; a new edition, by A. B. Searle, of the translation of E. Bourry's "A Treatise on Ceramic Industries"; and a new edition of "Modern Brickmaking," A. B. Searle.

ALL communications for the Imperial Mineral Resources Bureau should in future be sent to 2 Queen Anne's Gate Buildings, Westminster, S.W.1, to which address the Bureau has recently removed.

OUR ASTRONOMICAL COLUMN.

METCALF'S COMET.—The following orbit of the comet discovered by Mr. Metcalf on August 21 is by Miss Vinter Hansen and Mr. Fischer-Petersen from observations on August 21, 22, 25:—

$T = 1919$ Oct. 16·1984 G.M.T.
$\omega = 128° 33' 32''$
$\Omega = 311° 22' 93''$ } 1919·0
$i = 19° 58' 03''$
$\log q = 9·68280$

Error of middle place (observed *minus* computed), $+0·39' + 0·09'$.

Ephemeris for Greenwich Midnight.

		R.A.	N. Decl.	Log r	Log Δ
		h. m. s.	°		
Sept. 5	...	19 13 33	74 56·2	0·0147	9·3095
7	...	16 25 41	76 26·4	9·9997	9·3174
9	...	14 19 50	71 48·1	9·9842	9·3375
11	...	13 19 10	65 9·2	9·9681	9·3666
13	...	12 47 47	58 37·0	9·9515	9·4016

The magnitude remains nearly constant at $6\frac{1}{2}$, so that it is on the verge of naked-eye visibility.

Prof. Leuschner telegraphs that he identifies the comet with comet 1847 V (Brorsen), which was expected about this time. If this is confirmed, it will be the fourth member of the Neptune group to be observed at a second return, the others being Olbers's, Pons-Brooks's, and Westphal's. Halley's comet is not reckoned.

THE RECENT SHOWER OF PERSEIDS.—The return of these meteors was fairly well observed this year, though the full moon occurring on August 11 greatly moderated the visible aspect of the display. The weather was very favourable, and a considerable number of meteors were recorded by Mrs. F. Wilson at Totteridge, Mr. S. B. Maltey at Ilfracombe, Mr. A. King at Scunthorpe, in Lincolnshire, and Mr. Denning at Bristol. The radiant point appeared rather more diffuse or scattered than usual, but it exhibited the usual E.N.E. movement amongst the stars when observed on successive nights. A companion shower between α and β Persei was strikingly evident this year, and it furnished some fine meteors radiating from the point $48°+44°$. Other contemporary showers were remarked from $336°-10°$, $310°+80°$, $313°+48°$, $303°-9°$, and $303°+24°$; and between August 22–29 many small, slowish meteors were traced from positions at $332°+57°$ and $348°+61°$. The most brilliant Perseid seen flashed out on August 12 at 10h. 32m. G.M.T., and it was recorded at Totteridge, Bristol, and several other places. Its height was from 76 to 51 miles, and it passed from a point above 10 miles W.N.W. from Worcester to 10 miles E. of Tredegar in South Wales.

INTERNATIONAL STANDARDISATION.[1]

M. GUILLAUME, the distinguished director of the Bureau International, is to be congratulated on the issue of this important volume.

And yet it is a sad record; the greater part is occupied with the *procès-verbaux* of the fifth International Conference of Weights and Measures held at Paris in 1913, and attended by representatives of all the principal countries of the world, many of whom will never meet again. Much of the rest is the last work of Pierre Chappuis, whose death is recorded in a note to one of the papers by M. Guillaume, and to whose labours are due the determinations of so many important constants.

The *procès-verbaux* of the conference demand our first attention, for the meeting was, in many respects, important, and new ground was broken in various directions. The decisions reached by the delegates remain unfulfilled, and it will no doubt be the business of the sixth conference—which it is generally understood is to meet shortly—to consider the steps that should now be taken to give effect to them or to modify them as may seem best; for on some of the matters discussed considerable difference of opinion may well arise.

The fundamental business of the conference concerns weights and measures, the determination of standards of mass and length, the kilogram and the metre. The accurate calibration of these at once involves the measurement of temperature, and accordingly much of the work of the Bureau has dealt with scales of temperature; the scale of the constant-volume hydrogen thermometer was chosen as standard, and all temperatures referred to it. For the range 0° to 100°, or, indeed, for one rather outside these limits, this sufficed, but accurate determinations of temperature are now required down to the temperature of liquid air and up to perhaps 2500° C. The hydrogen thermometer is useless for such a range, and some steps were necessary to secure international agreement throughout the scale. There was no doubt that the absolute thermodynamic scale was the standard to aim at; on the other hand, there was no certainty as to the methods to be taken to realise that scale over the greater portion of the range. And so the conference, after emphasising the importance of researches which had for their object the perfecting of our knowledge of thermometric scales, expressed itself as (1) ready to substitute for the international service of weights and measures the Absolute scale in place of the "normal"—*i.e.* hydrogen—scale so soon as the relationship between these scales had, thanks to the researches contemplated, been determined with sufficient certainty, and (2) approving the determination of a certain number of standard temperatures as fixed points of the scale, to be suitably chosen and agreed upon as soon as possible.

With the view of giving effect to this last resolution, the conference invited the International Committee on Weights and Measures to arrange with the directors of the national laboratories which had been dealing with the measurement of temperature to meet at the Bureau to select the standard temperatures and to take steps to secure their general adoption. In

1 "Travaux et Mémoires du Bureau International des Poids et Mesures." Tome xvi. (Paris: Gauthier-Villars et Cie, 1917.)

view of this invitation there was to have been a preliminary meeting of the directors of some of the laboratories concerned in Berlin in September, 1914; much correspondence had passed and all arrangements were complete. Representatives of the Reichsanstalt visited the National Physical Laboratory in June, 1914, to compare standards. *Sed dis aliter visum.* So far as England and America are concerned, uniformity has been secured over the range from −182° C. to about 1100° C. by agreement between the directors of the Bureau of Standards and the National Physical Laboratory, and a common scale is in use at those institutions.

Another important question dealt with by the conference related to the standardisation of end measures of length. M. Pérard presented an interesting report on the results of his investigation as to the methods of comparing end measures and line measures, and particularly as to the accuracy with which a length gauge built up of a number of Johannsen slips, the use of which has become so familiar during the war, represented the sum of the lengths of the individual gauges. He states as the result of his measurements that it is necessary to add an amount of about eight-hundredths of a micron for each contact in the complex gauge, a quantity which is negligible for all practical purposes when using the standards. But the report led to an interesting discussion on another point. The metre is standard at 0° C.; end gauges are used chiefly in engineering work, and the temperature in engineering shops is probably between 15° C. and 20° C. If, then, a gauge is standard at zero, it is necessary when using it at 20° to know its temperature coefficient with some accuracy; two gauges, one of steel, the other of gun-metal (say), both correct at the standard temperature, differ appreciably at the temperature of use. Accordingly it has been proposed to standardise gauges for industrial purposes at a temperature more nearly that of an average shop; the correction which would then be required would in most cases be so small as to be negligible. English practice, of course, secures this; our measures are standard at 62° F. ($16^2/_3$° C.). In America a temperature of 20° C. has been suggested.

The International Committee of Weights and Measures had in 1909 preferred to accept 0° C. as the standard temperature, and the French Technical Section of Artillery had adopted that in the standards employed by it. After discussion the matter was referred to a special committee consisting of Dr. Foerster and MM. Blumbach,[2] Egoroff, Guillaume, and Pérard, and on their recommendation the conference decided to invite the International Committee to pursue its investigations with the view of reaching as complete knowledge as possible of the metrological properties of steels, as well as of the construction, standardisation, and method of use of end standards of length. Sir David Gill pointed out that, while recognising that the adoption of 0° C. as the standard temperature was theoretically desirable, he accepted the resolution as one which reserved a final decision on the question until the completion of the experiments. The question is a vital one if international standardisation is to become a reality. Its importance was illustrated during the war. A number of screw gauges about 2 in. in diameter were ordered on the Continent; the first batch received failed to pass inspection. They had been made correct at the freezing-point, and the expansion between that temperature and the English standard, 62° F., brought them outside the limits for acceptance. A visit to the Continental works was necessary to explain the point and put matters straight, causing delay and loss when time was of great importance.

A third decision of the conference is of special interest to meteorological circles. In correcting a barometer to a standard, sea-level at latitude 45° has been accepted, and a formula due to Clairaut, but modified by Broch, based on the accepted value of g in latitude 45° and its variations with latitude, has been employed. The accepted value for g at sea-level at latitude 45° has been 980·665 cm./sec.^{2}; recent observations, however, lead to 980·615 cm./sec.^{2} as the more correct value,[3] and it became a question whether to modify the normal standard or not. The conference decided against any modification in view of the fact that the figure 980·665 cm./sec.^{2} had received legislative sanction in many countries. They agreed, however, that observations into which the local value of g entered should be reduced, not by the usual formula, but by means of a numerical factor "determined, if possible, directly for the locality in question."

Now the unit of barometric pressure is the millibar —a pressure of 1000 dynes per sq. cm.—and the length of the column of mercury the weight of which gives rise to a pressure of one millibar is known as a baromil. A barometer the scale of which is graduated in baromils reads pressure in millibars. The length of the baromil is dependent on the value of g, and so varies with the locality, but it has been agreed by the International Conference of Meteorologists to take as standard the value of g at sea-level in latitude 45°, and the relation of the baromil to the mm. or the inch has been evaluated on the hypothesis that the standard value of g is 980·617 cm./sec.^{2}, the value assigned to it by Helmert. The decision, then, of the International Conference of Weights and Measures to retain as the standard value of g the old figure 980·665 involves, if it be used, a reduction of about 5 parts in 100,000 in the height of the column of mercury producing under standard conditions a pressure of one millibar. The certificates usually issued with barometers state the temperature at which the scales read pressure in millibars under standard conditions. If reduction is to be made to a nominal standard of gravity of 980·665 cm., these temperatures will all need to be reduced correspondingly. The difficulty, of course, is avoided if we take the true value of g at latitude 45° instead of the standard value as the figure to be used in calculating the length of the baromil, *i.e.* if we assume that this is one of the cases in which a numerical factor directly determined is to be employed, and some such course as this no doubt will be adopted.

A fourth matter of some interest which was discussed was the proposal to adopt in future legislation for metric countries the M.K.S. system of units, in which the unit of length is the metre, that of mass the kilogram, and of time the second. On this system the unit of force is the "Newton," the force required to produce per second in a mass of 1 kilogram a velocity of 1 metre per second. Thus,

1 Newton = 1000 × 100 C.G.S. units = 10^5 dynes.

The unit of work will be the work done by a Newton in moving its point of application 1 metre or $10^5 \times 10^2$ ergs, and this is the joule of the C.G.S. system. Accordingly, the unit of power is the watt.

As a result of the discussion the International Committee was invited to continue the study of all questions connected with legislation based on metrical units.

At the last session of the conference M. Battistella, the Italian delegate, raised a far-reaching question. The work of the conference and of the committee

[2] M. Blumbach's many friends will be glad to know that he is well: a message has been received from him asking for help to reconstitute the Weights and Measures Department in Russia.

[3] The value given by Helmert is 980·617 cm./sec.^{2}.

had hitherto, he pointed out, been limited to the fundamental standards of mass and length and questions intimately connected with these. M. Battistella urged that this was insufficient to secure uniformity in all the details of importance to international science. In the name of his Government he directed attention to (1) the necessity for a legal definition, not only of the fundamental units of mass and length, but also of a whole series of connected units—units dealt with in the study of light, heat, engineering, and electrical problems, and others, as well as for the specification of the instruments best suited for the measurement of these quantities; and (2) the importance of the standardisation of the types of instruments to be employed so as to secure uniformity among countries using the metric system. As a result the International Committee was entrusted with the mandate of examining the proposal of the Italian delegate with the view of securing agreement on the questions raised.

Enough has, perhaps, been written to show that the matters under discussion were of no small importance. None of them were settled; it remains for a future conference to examine them afresh and to decide each in the manner which promises best to be of service to the world and to turn to advantage the lessons of the past five years of trial.

And now there is no space to describe the other half of the volume: M. Pérard's elaborate note on the reduction of certain classes of observation or M. Chappuis's two papers on the determination of the boiling-point of sulphur and the coefficient of dilatation of mercury. It must suffice to mention the results. For the boiling-point of sulphur on the thermodynamic scale under normal pressure he finds the value 444·60°. Holborn and Henning give 444·51°, and Day and Sosman 444·55°. The value at present in use at the National Physical Laboratory is 444·5°.

For the coefficient of dilatation of mercury his value is $0{\cdot}18162884 \times 10^{-3} + 8{\cdot}5962282 \times 10^{-9}$ T. This value does not differ greatly from that deduced from his own earlier experiments of 1890; the differences between these results and those of Callendar and Moss (Phil. Trans., 1911) are considerably greater. For the range from 60° to 100°, where Chappuis's two results agree very closely, the difference between them and the figures of Callendar and Moss would correspond with a temperature error of 0·25°, an error ten times greater than that which M. Chappuis considers possible.

M. Chappuis died as the proofs of his paper were passing through the press. Those who know his work will wish to join in M. Guillaume's tribute to his memory. He writes:—"These two determinations of the coefficient of dilatation of mercury, separated by a quarter of a century, carried out by methods entirely different and with instruments which had no part in common, and yet in close agreement, will remain for metrologists of the future among the finest examples of the work of an experimenter gifted with consummate skill, with a devotion to his task which stood every test and with an intense desire to reach the truth." R. T. G.

SOME INDIAN SUGAR-CANES AND THEIR ORIGIN.

DR. C. A. BARBER, Government Sugar-Cane Expert, Madras, continuing his studies on Indian sugar-canes, has given an account of the classification of two new groups which he describes as Saretha and Sunnabile (Memoirs of the Department of Agriculture in India, Botanical Series ix., No. 4). In the course of study of the Indian canes a sharp distinction was observed between two classes. There was, on one hand, a large series of thick, juicy canes commonly grown on a crop-scale in the more tropical parts, or in the northern parts usually in small plots under high cultivation near large towns, in which they were used for eating as fruit. A second series of thin, hardy canes, grown under field conditions all over India, especially in the north, were unfitted for chewing, but were crushed and made into "jaggery" or "gur." It is this second series which includes the subject of the memoir. In contrast with the first series these thin canes are considered to be indigenous to India, and were found to include several well-defined classes. A number of apparently isolated forms from all parts of the country were at first difficult of arrangement, but were afterwards found to fall into two groups, characterised by bending or erect leaf-tips and presence or absence of circlets of hairs at the nodes; the canes known as Saretha and Sunnabile have been selected to give names to the new groups. In classifying varieties under these two groups the characters usually employed in systematic work, such as differences in the floral organs and size of organs and plants, have not been found helpful, but dependence has been placed on a series of minute local differences. Thus in all the Saretha group there is a minute incrustation on the rind, as if it had been attacked by a small mite, whereas this is absent in the Sunnabile group. The density of bloom is greater in the Saretha group, but the blackening of this bloom by fungus is sharper and more circumscribed in the Sunnabile group. Thickness of stem and size and vigour of plant seem to be of no value; and the existence of insignificant characters in canes differing considerably in external appearance, and extending through wide stretches of country under varying climatic and cultural conditions, adds to their importance. Some sixty to seventy such characters are dealt with in detail.

Dr. Barber further points out that his classification is not merely an empirical statement of unconnected differences, a sort of analytical key for the separation of varieties, but also presents data for a statement on the lines of evolution among a section of cultivated canes. He claims to have advanced towards solving the origin of cultivated canes from their wild ancestor, and to have established a series of connecting links between cultivated canes and the wild species of Saccharum now growing in India. A wide collection of specimens shows that there are some very distinct varieties of *Saccharum spontaneum* more or less confined to definite geographical regions. A development in the size of the vegetative organs is observed in passing from the dry to the humid tracts in India similar to that met with in the Saretha and Sunnabile series of sugar-canes, and in the detailed list of characters showing differences between the two groups we find a number mentioned in which the Saretha group approaches *S. spontaneum*. Such are the black incrustation on the stem, the circlet of hairs on the nodes, and certain leaf-characters, and these resemblances suggest that the Saretha group is the more primitive. But as a study of the seedlings of *S. spontaneum* raised at Coimbatore shows differences among themselves similar to those obtaining between the two groups, it is considered that the Sunnabile varieties are also traceable to the same wild species.

Dr. Barber describes a method for building up an ideal cane for each variety and group. The results have been reduced to curves, which show the differences sufficiently well, but involve considerable labour, as in some cases they are based on as many as

10,000 individual measurements. He has recently dissected some fifty stools, representing twenty-four varieties, and finds overwhelming evidence that the late canes are the thickest, thus reversing earlier conclusions drawn from the behaviour of the Punjab canes late in the season.

GENERAL PHYSIOLOGY.

INCREASED specialisation brings with it further subdivision of the sciences, and most of the new journals which are founded are restricted to narrower fields than those of existing publications. Now and then, however, an attempt is made to counteract the evils of specialisation by insistence on broad principles and by the provision of a meeting-place for workers in various branches of the same or of kindred subjects. Some such considerations must have led to the recent foundation of the *Journal of General Physiology*, which is edited by Prof. Jacques Loeb, a physiologist, and Prof. W. J. V. Osterhout, a botanist, and published by the Rockefeller Institute of Medical Research. This journal, which was referred to in our issue of October 31 last, is "devoted to the explanation of life-phenomena on the basis of the physical and chemical constitution of living matter," and first appeared in September last. Its scope may, to some extent, be illustrated by a number of reprints which we have received; they are of papers by Prof. Loeb, some physico-chemical, some botanical in nature.

In three papers on amphoteric colloids, which have appeared in the first three numbers of the new journal, Prof. Loeb has continued work previously published by him in the *Journal of Biological Chemistry*. Contrary to what is generally stated in the literature of colloid chemistry, he concludes that the physical properties of gelatin near the point of neutrality are affected only by the cations of a neutral salt, and not by its anions. "The error into which the colloid chemists have fallen is due to the fact that they always investigated the effect of a neutral salt on a protein in the presence of the salt, while the writer took the precaution to wash the excess of salt away after it had time to act on the gelatin." Accordingly, a quantity of finely powdered gelatin is left for one hour in contact with a neutral salt solution of known concentration. The powder is then filtered off, and the excess of salt removed by repeated washing with water. The gelatin is liquefied by heating to 50° C., and diluted with water to make a 1 per cent. solution. Then, for instance, the osmotic pressure of the solution is determined in a collodion bag. Treatment with salts of a bivalent metal ($MgCl_2$, $CaCl_2$) does not lead to an increase of osmotic pressure, but treatment with sufficiently concentrated solutions of salts of monovalent metals (NaCl, NaCNS, $LiNO_3$, Na_2SO_4) results in an increased osmotic pressure. When the powdered gelatin is similarly treated with hydrochloric acid of varying concentrations, it is found that about N/256 HCl (which brings the gelatin to its isoelectric point, p_H=4·7) makes the total swelling, the osmotic pressure, the conductivity, and the "alcohol number" minima. On the less acid side gelatin is regarded as existing as a negative ion (*e.g.* gelatin-H or gelatin-Na); on the more acid side as a cation (gelatin-Cl or gelatin-OH).

In a later paper the author has determined the amount of bromine in combination with gelatin after treatment with hydrobromic acid of varying concentrations. He regards the curves of osmotic pressure as an "unequivocal function" of the number of gelatin bromide molecules formed. Prof. Loeb has evidently not seen the recent very careful and elaborate investigation, by Sörensen and his collaborators, of egg-albumin, in the *Comptes rendus* of the Carlsberg laboratory. A considerable section of this monograph deals theoretically and practically with the osmotic pressure of an amphoteric colloid of great purity in the presence of electrolytes, and takes into account factors which are not dealt with by Prof. Loeb's simple procedure. It will be interesting to see whether, after a perusal of Sörensen's monograph, Prof. Loeb still maintains his somewhat sweeping criticism of colloid chemists.

The botanical reprints are concerned with the mechanism of regeneration in *Bryophyllum calycinum*. The leaves of this plant possess peculiar dormant buds in each of the notches, which buds may give rise to roots and shoots so soon as the leaf is separated from the plant. The chemical mechanism of the process is dealt with in a paper in the *Annales de l'Institut Pasteur*, and is a rare example of work published in English in a French journal. In other papers in the new journal the influence of the mass of a leaf on the quantity of shoots regenerated in an isolated piece of stem is measured, and the physiological basis of polarity is discussed. It is suggested that an inhibitory influence of the leaf upon shoot-formation (as compared with root-formation) is due to inhibitory substances secreted in the leaf, and carried by the sap from the leaf towards the base of the stem.

ÆTHER AND MATTER: BEING REMARKS ON INERTIA, AND ON RADIATION, AND ON THE POSSIBLE STRUCTURE OF ATOMS.[1]

PART I.—INERTIA.

WE are each of us flying through space at nineteen miles a second, probably much more. Nothing is propelling us; we continue to move by our own inertia, simply because there is nothing to stop us. Motion is a fundamental property of matter. No piece of matter is at rest in the æther, the chances are infinite against any piece having the particular velocity zero; every bit is moving steadily at some given speed, unless acted on by unbalanced force. Then it is accelerated—changed either in speed or direction, or both.

As a matter of fact, we, like other bodies on the earth, are acted on by two slight, unbalanced forces—one which makes us revolve round the earth once a day, like a satellite; the other which makes us revolve round the sun once a year, like a planet or asteroid. Our annual revolution is not because we are attached to the earth; we are not attached, but revolve as independent bodies, and would revolve in just the same time and way if the earth were suddenly obliterated; only then we should find the diurnal revolution transmuted into a twenty-four-hour rotation round our own centres of gravity, and the eccentricity of our annual orbit very slightly changed. In any case, there is no propelling force, only a residual radial force producing curvature of path.

A railway train, or a ship moving steadily, is likewise subject to no resultant force. Propulsion and resistance balance. The whole power of an engine, after the start, is spent in overcoming friction. The motion continues solely by inertia. Any steadily moving body is an example of the first law of motion. You need not try to think of a body under no force

[1] Amplified from a discourse delivered at the Royal Institution on Friday, February 28, 1919, by Sir Oliver J. Lodge, F.R.S.

at all; you cannot think of such a body on the earth, but you can think of one under no resultant force, *i.e.* under balanced forces. Such a body moves by reason of its inertia alone. It is in equilibrium; it is not at rest.

But we have no sense of straightforward locomotion, and not the slightest clue to either the magnitude or direction of our motion through space. We can ascertain approximately how the sun is moving with reference to our system or cosmos of stars, but we do not know at what rate that system is itself moving. For all we know, it may be moving very fast, hundreds of miles per second.

We have a sense of acceleration, however; we experience it in a lift as it begins to descend; and if the sensation is repeated often enough, as on a rough sea, the result is unpleasant. We have also a sense of rotation; we can tell when our vehicle—say a Tube train—turns a corner in the dark. Most animals appear to have a sense of rotation, apparently located in the ear. But we have no sense of direct translation; and we have so far failed to devise any instrumental means for detecting our motion through the æther of space.

The failure is not for lack of trying. Many experiments have been tried, but there is always some compensating effect; so we get no answer to the question: At what rate and in what direction are we moving? The best known experiment is that of Michelson and Morley, the result of which seems to assert that the æther clings to the earth, or that the earth is not moving through any kind of substance. But Fizeau's classical experiment showed that a transparent body carried with it none of the internal æther of space; and experiments made by myself[2] at Liverpool in the nineties of last century showed that a rapidly moving opaque body carries no external æther with it, that there is no perceptible viscous drag or cling between matter and æther, and accordingly demonstrates that stagnation or absence of relative æther drift past the earth is not a reasonable explanation of Michelson's negative result.

The two experiments together, in fact, ought to be taken as establishing the reality of the most interesting of all the compensating effects yet discovered, viz. the FitzGerald-Lorentz contraction of all matter in motion, which the electrical theory of cohesion renders so extremely probable. It only amounts to a 3-in. shrinkage in the whole diameter of the earth in the direction of motion; but it is enough. This slight contraction or change of shape in moving bodies I regard as the definite and interesting compensating effect in this case. Incidentally, moreover, it establishes the electrical, *i.e.* the chemical, nature of cohesion. For, given that cohesion is a residual chemical affinity—due to the outstanding attraction of molecules composed of neutral groups of equal and opposite electric charges, brought so near together that the attraction between molecules is no longer averaged to zero[3]—then, on orthodox Maxwellian electric theory, a diminution of this force due to lateral motion is inevitable. And the resulting lateral expansion or longitudinal contraction, or both, is of the right order of magnitude. So this acts as a previously quite unsuspected compensating effect, which exactly neutralises the drift effect otherwise to be anticipated. Thus, by superposition of two positive consequences of drift, the Michelson experiment, like every other yet made, declines to indicate that there is any drift at all.

Hence, after many such negative results, it seems to become hopeless to inquire experimentally as to our motion through æther, unless, indeed, gravitation were exempt from the otherwise universal compensation. In that case the electrical theory of matter applied to the motion of planets might yield a residual result. But my recent inquiry into this problem has suggested that gravitation, too, is in the conspiracy,[4] and in that case there is some ground for the contention of the extreme Relativists, not only that we do not know our motion—with which everyone agrees—but also that we never shall know it; and, in fact, that motion of matter through æther is a phrase without meaning.

I hope we shall not too readily shut the door on further attempts in this direction; and as a conservative physicist I may be allowed to lament the extraordinary complexity introduced into physics and into natural philosophy by the principle of relativity, as so remarkably and powerfully developed by the mathematical genius of Einstein, with complication even of our fundamental ideas of space and time. The complications do not commend themselves to all of us, and I for one should be glad to return to the pristine simplicity of Newtonian dynamics, modified, of course, by the electrical theory of matter; admitting the FitzGerald-Lorentz contraction, and admitting also the variation of effective inertia with speed. These things do not destroy, but supplement, Newtonian dynamics. They generalise it in a legitimate and intelligible manner. Such complications as these are clearly in accordance with truth, and are to be welcomed; but the complicated theory of gravitation created this century by Einstein, and developed by his successors, and the consequent overhauling of space and time relations, do not at present commend themselves to me, or, I think, to others of what I suppose must be called the older school.

Meanwhile, the full-blown theory has the courage of its conviction and has predicted a definite result, viz. the deflection of a ray of light by the sun's limb, equal to 1·75 seconds of arc. The prediction is going to be tested during the solar eclipse of May 29 this year, between Brazil and the Gulf of Guinea. Let the issue be clearly understood. If a star-ray grazing the sun is deflected $\frac{3}{4}$ second it will mean only that light has weight, that the wave-front not only simulates the properties of matter by carrying momentum—as we know it does from the investigations of Nichols and Hull, Poynting and Barlow, and others—but that it is even subject to gravity. For this would be the angle between the asymptotes of a cometary orbit when the comet is moving with the speed of light and passing close to the sun.[5] But the principle of relativity—through the refractive or converging influence of a strong divergent gravitational field—demands a greater deflection than this, more than twice as great. So there are three alternate deflections before us, to be settled by observation:—1·75 sec.; 0·75 sec.; and zero. Let us hope that the result of this or of some other eclipse-opportunity may be definite enough to discriminate clearly and quantitatively between these three alternative values, any one of which should be equally welcome to any lover of truth.

If the first answer is given decisively, it will be a conspicuous triumph for the theory of relativity, and will for a time be hailed as a death-blow to the æther. I claim beforehand that such a contention is illegitimate, that the reality of the æther of space depends on other things, and that the establishment of the principle of relativity leaves it as real as before; though truly it becomes even less accessible, less

[2] See Phil. Trans., vol. clxxxiv. (1893), pp. 727–804, and vol. clxxxix. (1897), pp. 149–66.

[3] See, for instance, my book on electrons, chap. xvi.

[4] See the *Phil. Mag.* for August, 1917, and February, 1918, pp. 145, 155 and 156.

[5] See, for instance, my paper in the *Phil. Mag.* for August, 1917, p. 93.

amenable to experiment, than we might have hoped. Nevertheless, the æther is needed for any clear conception of potential energy, for any explanation of elasticity, for any physical idea of the forces which unite and hold together the discrete particles of matter whether by gravitation or cohesion or electric or magnetic attraction, as well as for any reasonable understanding of what is meant by the velocity of light. Let us try to realise the position beforehand; for we shall be handicapped in the progress of our knowledge of the relation between matter and æther until these fundamental things are settled, and until everyone agrees that the æther has a real existence. I want people generally to admit that the æther is itself stationary as regards locomotion, and that it is the seat of all potential energy; and further, at least as a surmise, that it is the medium out of which matter is probably made, and in which matter is perpetually moving by reason of its fundamental property called inertia—a property the full explanation of which must, I expect, ultimately be relegated to and considered as a property derived from the æther itself.

I call this lecture "Æther and Matter," but I might equally well have called it "Inertia," for that is the main theme with which I have to deal—at least, in this first part.

Is there anything else besides matter which possesses or seems to possess inertia? Faraday discovered that an electric current had a property which bore some analogy to inertia, a property clearly depending on its magnetic field. Every current, even a convection current, is necessarily surrounded by lines of magnetic force, and when the magnetic field is intense the current behaves as if it had considerable inertia. Faraday at first called the effect "the extra current." Maxwell called it "self-induction." The latter is the better name.

To show it, I start a current in a circuit containing a stout ring of laterally subdivided iron round which the current-conveying wire is wound, and I put in circuit an instrument which only responds when the current has risen to nearly its full strength. A current usually rises what is called instantaneously, but here there is a very noticable delay between pressing down the key and the response of the instrument. The lag shown is only a second or two, but with care I can adjust it until it is a quarter of a minute. Such delay or lag in establishing a current would be fatal to electric telegraphy. In practice the delay is reduced to a minimum by using its early values, and the actual response is exceedingly quick. Still, the law of rise of current is quite definite; there is no exception, it is only a question of degree; and the law is the same as that appropriate to the pulling of a barge on a canal. A barge gets up speed slowly, at a rate depending on its mass or inertia, and it ultimately attains a steady speed when the resistance balances the pull.

That is exactly the case of a steady current obeying Ohm's law; the E.M.F. is balanced by the resistance, the propelling force is zero, and the current flows by what we may call its own inertia—its own momentum.

To stop the current you must either increase the resistance or suspend the propelling force. If you interpose an obstacle suddenly, the motion stops with violence—a collision in the case of a train or barge, a flash in the case of electric current. This is what Faraday called "the extra current at break"; and if you are holding the wires in your hand when a current is suddenly broken in a circuit of large self-induction, you may get a nasty shock.

If you could abolish electric resistance, a current would go on for ever without propelling force.

An amazing experiment has been made by Kamerlingh Onnes at Leyden, who first cooled a metal ring down to within 4° of Absolute zero by means of liquid helium, and then started a current through it by a momentary magnetic impulse. Instead of stopping in a minute fraction of a second, as usual, the current went on and on, not for seconds, but for days. In four days it had fallen to half-strength, and there were traces of it a week later. A most suggestive experiment as to the nature of metallic conduction, as well as a demonstration of the fly-wheel-like momentum of an electric current!

This electromagnetic analogue to mechanical momentum or inertia is explicable (or supposed to be explicable) in terms of the magnetic field surrounding the current, *i.e.* really (as I think) in terms of a property of the æther of space. It exactly simulates inertia; but is it an imitation or is it the same thing? Can it be said that an electric charge possesses inertia in its own right, and retains it always, as matter does, whether it be moving or whether it be stationary?

The question was brilliantly answered by your professor of natural philosophy, Sir J. J. Thomson, so long ago as 1881. He calculated the inertia or quasi "mass" of an electric charge e on a sphere of radius a, and showed that it was $m = \frac{2\mu e^2}{3a}$.

The μ need not be attended to now, though it is really the most important of all—being a great æthereal constant of utterly unknown value[6]—but for our present purpose the μ merely signifies that the e must be measured in electromagnetic, not electrostatic, measure when the formula is interpreted numerically with $\mu = 1$.

At the date 1881 this expression for true electric inertia, though an interesting result, seemed too absurdly small to have any practical significance. Take a sphere like a football, 20 cm. or 8 in. in diameter; charge it until it is ready to give more than an inch spark, say up to 60,000 volts; then calculate the inertia or equivalent mass corresponding with the charge. If I have done the arithmetic right, it comes out one-third of a millionth of a millionth of a milligram (3×10^{-16}). Absurdly small! Yes, but not zero. And whenever a quantity is not nothing, there is no telling what importance may not have to be attached to it sooner or later. Nothing real can be so small as to be really negligible in the long run as knowledge progresses. Something at present unforeseen may bring it into prominence. So it has turned out in this case. The infinitesimal result of nearly forty years ago to-day dominates the horizon. It was in some sort the dawn of a new era in physics.

Consider it further. Clearly the inertia depends not on the charge only, but on its concentration. The radius of the sphere occurs in the denominator of the expression. The same charge on a sphere 2 cm. in diameter would have ten times the inertia; on a sphere as small as an atom the inertia would be a hundred million times bigger still. But then even that is small; moreover, an atom could scarcely be expected to hold such a charge. Nevertheless, allowing only a reasonable potential, it might seem that atomic inertia could be sensibly increased by an electric charge. But, no; even on a sphere as small as an atom the concentration turns out insufficient; the effect is still excessively minute. Yet as electric inertia at given potential depends on linear dimen-

[6] I have guessed that it is a density of 10^{12} grams per c.c.$\div 4\pi$. See "The Ether of Space," Appendix 2; also the *Phil. Mag.* for April, 1907.

sions, while material inertia depends on those dimensions cubed, there must be a size when the two are equal, *i.e.* when one might account for the other.

Write the charge in terms of electrostatic potential V.

$$e = KaV$$

then

$$m = \frac{2KaV^2}{3c^2}$$

where c is $1/\sqrt{(\mu K)}$, the velocity of light.

Put this expression for m equal to $\pi a^3\rho$, the ordinary mass.

Then the potential at which the two will be equal is

$$V_1 = ac\sqrt{\left(\frac{2\pi\rho}{K}\right)}$$

which, for density of water and for a sphere 10^{-13} cm. radius, is two volts—quite a reasonable electrolytic value, such as is to be expected among atoms.[7]

The moral of this elementary, but not very satisfactory, argument is that not for bodies of atomic size, but for something 100,000 times smaller in linear dimensions, is it possible to explain inertia electromagnetically. But forty, or even twenty, years ago one would have said: There are no bodies of this size; nothing can be smaller than an atom! The strange thing is that, as nearly everyone knows now, bodies of this size have been discovered. They were isolated by Sir J. J. Thomson in 1899, having been gradually led up to by Crookes's and many other experiments on cathode rays; and they are shown to be an apparently invisible unit or atom of electricity the inertia of which is wholly electric.

The proof of this last statement I can only briefly indicate. It is established by the effect of speed on electric inertia. If an electric charge is moving with something approaching the velocity of light, its inertia increases without limit; and the formula given about 1889 by Heaviside, Thomson, and others for electric inertia as a function of speed is, in its very simplest form,

$$m = \frac{2\mu e^2}{3a}\left(1 + \frac{v^2}{2c^2} + \text{higher powers}\right).$$

The velocity of light squared occurs in the denominator, so, before we can observe the increase, enormous speeds are necessary. A cannon-ball, or even the earth in its orbit, is hopelessly slow; and we know no artificial means of getting up such a speed as this last, viz. about nineteen miles a second. But, fortunately, radium does spontaneously what we cannot do; it expels electrons with something less, but not very much less, than the speed of light; and Kauffmann's measure of the mass of these projectiles, thus flying at prodigious velocities, confirms the theory, and removes any doubt as to the reality of purely and wholly electric inertia for electrons.

Furthermore, it was found that the very same electrons can be split off or detached from any or every kind of atom, that there is only one kind of negative electron; and though at first there appeared to be many kinds of positively charged particles, the evidence is tending to the discovery of a single kind of positive lectron likewise; so it is natural to suppose that electrons are an essential ingredient in matter. And since they possess inertia, even those which are clearly disembodied electric charges, it becomes possible to surmise that in some sense, or in a certain grouping, they constitute the atom; that they confer upon it the inertia with which we are familiar; and that, in fact, electric inertia is the only inertia that exists.

Electric inertia began as the simulacrum of material inertia; it has shown itself the very same thing, and it seems likely to end by displacing every other kind of inertia altogether.

This is the electrical theory of matter.

Assuming this theory for the present as a working hypothesis, we may say that material inertia is explained electromagnetically, *i.e.* is explained in terms of the magnetic field which necessarily surrounds and accompanies every charge in motion, since a charge in motion constitutes a current. For on this view a material body is but an aggregate of such charges grouped according to some definite pattern, positive and negative charges interlaced or somehow intertwined, and so far apart in proportion to their size that they do not interfere with each other or cancel each other, nor apparently overlap or encroach on each other's field, to any measurable extent. Is this possible? It is. For, comparing the size of an electron with the size of an atom, we perceive that they are relatively of the same order as the size of a planet and the size of a solar system. So it becomes possible to think of an atom as a sort of solar system, with a positive nucleus or sun surrounded by negative electrons revolving in regular orbits round it.

On this view, or, indeed, in any form of the electrical theory of matter, the atom of matter consists mainly of empty space; in other words, it is excessively porous, just as the solar system is mainly empty space, and may be spoken of as excessively porous, the actual material lumps being almost infinitesimal in proportion to the total bulk. A rapid projectile or a ray of light passing through the solar system would be unlikely to hit anything; the chances would be strongly against a collision. So also, if a point be thrown through an atom, the chance of its hitting anything is about 1 in 10,000. It might pass through 10,000 atoms before striking. This experiment has been tried by C. T. R. Wilson and others, and that is, roughly speaking, the result. Sooner or later a radium projectile meets with an obstacle and is stopped, but it traverses a good number of atoms on the average; it traverses quite a perceptible distance even in a dense solid before it strikes a nucleus.

Matter accordingly seems to me—to us, I may say, for in this most physicists are, I think, agreed—a gossamer or milky-way structure, an impalpable acti-

[7] The argument is plausible, and, taken as an illustration on ordinary lines, will serve: but considered seriously it may be quite fallacious, although the main consequences which in the text are going to be drawn are correct. Few things are more surprising than the extraordinarily large charge held by or constituting an electron in proportion to its size. The charge is so large that ordinary arguments about electricity as it exists on material spheres cannot be expected to apply. If they did, or in so far as they do, the potential of an electron would not be two volts, but well over a million volts; and the density of the æthereal substance of which it is presumably composed (if its electric inertia is to be derived in any simple, ordinary way from its bulk) would have to be nothing like that of water, but of the order 10^{12}, or a billion times the density of water. A thousand tons, in fact, to the cubic millimetre.

We are here out of our depth among quantities on which a great deal of work has to be done to reduce them to order. Yet it must not be supposed that these figures are nonsensical. They require serious consideration; and that is all that can be said for them. I do not think there is any sense in talking about the potential of an indivisible unit of charge, but we can talk about the potential existing at the confines of an atom; and that is a reasonable magnitude, about 14 volts in the case of hydrogen, and not very different for other elements.

But on the other side of the subject everything points to the density of æther being exceedingly high, though perhaps not so high as the above estimate. It must at least be greatly denser than platinum or lead, and probably immensely denser.

A difficulty is often felt as to how ordinary matter like a planet can move through such a medium without friction. Density, however, does not involve viscosity; the two are disconnected; and resistance to motion would be caused only by viscosity, of which the æther appears to have none. There are many ways, more or less satisfactory, of picturing the perfectly free motion of matter through an exceedingly substantial æther of space; there would be innumerable difficulties in supposing friction and consequent generation of heat. It is quite certain that whatever the æther does it does not dissipate energy. That imperfection belongs to the province of molecularly constituted matter.

dent in the substantial æther. Here a speck and there a speck, but, for the great bulk of it, empty space!

"Impalpable" is not the right word, for matter is essentially palpable. It is because it appeals so directly to our senses that we attend to it so vividly. It forces itself on our attention, while the æther eludes us. And why? Clearly because our bodies are composed—our sense organs are composed—of this very matter. On the material side we are part of, and thoroughly at home in, the material universe. Whereas the æther is elusive—we know nothing of it directly—and though our eyes are instruments for receiving æthereal tremors excited by agitated electrons, we only know that fact, or half know it, by rather recondite inference. Light really tells us nothing about its own nature, but only about the superficial aspect of that gross and palpable matter which has interfered with and scattered it before it enters our eye.

Nevertheless, the atoms of this solid-seeming flesh and matter as we know it, when analysed into constituents, are turning out to be composed each of a definite grouping of ultra-minute particles, the positive and negative electrons, which themselves scarcely occupy any space (save as soldiers occupy a country), and which appear to be of two kinds only: the ultimate indivisible units of positive and negative electricity.

(To be continued.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MANCHESTER.—The following appointments are announced:—Mr. A. G. Ogilvie, reader in geography; Mr. J. Macmurray, lecturer in philosophy; Messrs. A. Gardner and R. L. Newell, demonstrators in anatomy. Mr. E. N. Ramsbottom has been elected to a research fellowship in public health.

DR. J. GRAHAM has been appointed professor of anatomy in the Anderson College of Medicine, Glasgow, in succession to the late Dr. A. M. Buchanan.

THE sum of 700,000*l.* has been given by Mr. G. Eastman, head of the Eastman Kodak Co., for the establishment of a school of music in connection with the University of Rochester, New York.

DR. G. SPENCER MELVIN, lecturer on experimental physiology in the University of Aberdeen, has been appointed professor of physiology in Queen's University, Kingston, Ontario.

THE PRINCE OF WALES, in acknowledging the degree of LL.D. conferred upon him on August 26 by the University of Toronto, said that the anti-toxin establishment with which the University is equipped had rendered invaluable service during the war for the forces of the British Empire and the Allies.

PROF. C. GOLGI has retired from the chair of general pathology and histology in the University of Pavia, but he remains in charge of the institute connected with it. A gold medal and souvenir album were recently presented to him, and a scholarship founded in his honour is to be given to the orphan of some physician killed during the late war.

DR. F. J. WILSON has been appointed professor of inorganic and analytical chemistry, and Dr. I. M. Heilbron professor of organic chemistry, at the Glasgow Technical College. Mr. W. Kerr has been appointed research assistant in the department of mechanical engineering at the same institution. The new development fund of the college has now reached the total of 35,000*l.*, the following donations having recently been received:—From Mr. W. J. Chrystal, 1000*l.*; Mr. and Mrs. George Morton, 500*l.*; Messrs. W. Teacher and Sons, 500*l.*; Messrs. Alexander Stephen and Sons, Ltd., 500*l.*; the Anchor Line (Henderson Bros.), Ltd., 250*l.*; Messrs. Macfarlane, Lang, and Co., Ltd., 250*l.*; and Mr. James Reid, 250*l.*

THE Civil Service Commissioners announce that an examination will begin on October 28 for the purpose of filling vacancies as assistant examiners in the Patent Office. The examination will be confined in the main to candidates who have served in his Majesty's Forces, and will consist of a qualifying examination followed by interview by a selection board. The subjects of the qualifying examination are English composition, *précis*-writing, general knowledge, and *one* of the following:—General chemistry, electricity and magnetism, or mechanics and mechanism. The limits of age are 20–30. Initial salary 150*l.* a year, together with a war bonus. Copies of the regulations and forms of application may be obtained from the Secretary, Civil Service Commission, Burlington Gardens, London, W.1. The last day for making application is September 18.

THE United States General Education Board has granted 16,000 dollars to the National Committee on Mathematical Requirements, appointed by the National Mathematical Association of America, for the purpose of undertaking a study looking to improvements in the mathematical curriculum of the secondary schools of the country. Mathematicians, as well as educators in general, have in recent years criticised the prevailing high-school work in mathematics on the ground that much of the material is of little practical value, and on the further ground that the high-school curriculum in mathematics takes too little account of modern developments in this science. The American Mathematical Association is made up of the leading professors and teachers of mathematics in American colleges and universities. It has appointed to conduct the inquiry a committee composed of four university professors of mathematics and four secondary-school teachers of mathematics. Having no funds, this body applied to the General Education Board for assistance. The board itself will not take any part in the study or make recommendations. Prof. Young, of Dartmouth College, and Prof. Fobert, Technical High School, Chicago, will devote their entire time to the work for a year or more.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 18.—M. Léon Guignard in the chair.—G. **Humbert**: The particular representations of an integer by positive forms of Hermite in an imaginary quadratic body.—H. **Andoyer**: The development of a general function of the radius vector of the eccentric anomaly in elliptic movement.—E. L. **Bouvier** and d'E. **de Charmoy**: Mutation of a Caridina into an Ortmannia, and general observations on the evolutive mutations of fresh-water shrimps of the family of the Atyidæ.—E. **Kogbetliantz**: Ultraspherical series.—R. **Garnier**: Vectorial fields with indeterminate asymptotic directions.—E. **Jouguet**: A problem of generalised hydraulics. Flow of a burning gaseous mixture.—A. **Véronnet**: Ellipsoidal figures of equilibrium of a liquid in rotation; variation of the major axis.—G. **Fayet** and A. **Schaumasse**: The next return of the periodic comet 1911 VII. (Schaumasse). Taking into account the perturbations

in the orbit caused by the proximity of the comet to Jupiter in 1913, new elements have been worked out. It should be sought for in the beginning of September. —R. **Baillaud**: An impersonal photographic astrolabe. —P. **Nicolardot**: The action of reagents upon glass-powder. Eight kinds of glass were studied, and the amounts dissolved by pure water and decinormal hydrochloric acid determined for three grades of powder, fine, medium, and coarse.—S. **Posternak**: The saturated sodium salt of inosite hexaphosphate. A correction of data given in an earlier paper.—Ch. **Boulin** and L. J. **Simon**: The evolution of a mixture of methyl sulphate and chlorosulphonic acid.—J. **Bougault** and P. **Robin**: The oxidation of benzaldoxime. This oxime, on treatment with iodine and sodium carbonate, gives benzoic acid, benzaldoxime peroxide, benzoyl-benzaldoxime, and dibenzenyl-oxoazo-oxime.

SYDNEY.

Linnean Society of New South Wales, June 25.—Mr. J. J. Fletcher, president, in the chair.—Dr. A. J. **Turner**: Revision of Australian Lepidoptera. Part vi. (continued). Thirty-two genera and ninety-five species of the subfamily Boarmianæ are recorded or described, five genera and forty species being described as new.—Dr. R. **Greig-Smith**: The germicidal activity of the eucalyptus oils. Part ii. Eucalyptus oils are irregular in their action upon *B. coli communis*, and duplicate experiments may show a considerable amount of variation. Cineol begins to act in about a minute and a half; phenol acts instantly. The curves of cineol and phenol cross in 5 minutes with a dilution of 1:75 at 20°. The phenol coefficient of cineol in 15 minutes at 20° is 3·1; it rises to 3·4 in 30 minutes, and then slowly declines to 2·8 in 4 hours. Aromadendral is the most active of the constituents of the oils. The phenol coefficient is 21·1 in 30 minutes. The next most active is piperitone (4·1), and possibly phellandrene. Pinene and sesquiterpene are low (0·8 to 0·5). The rectified oils of *E. cinerea* and *E. Smithii* are more efficient than the crude oils. In the case of the oil of *E. cinerea*, this appears to be due to the hydrolysis of the esters and the subsequent oxidation of the alcohols to aldehydes. Treatment with alkali did not reduce the efficiency of the acid-rectified oil. The addition of acetic acid to the crude oil doubled the germicidal power in the course of 3½ months. The germicidal activity of the rectified and crude oils of *E. cinerea* is proportional to the starch-iodide reaction, and not to the acidity, but this does not hold for the oils as a class. The rectified oil of *E. polybractea* is less efficient than the crude oil. This may be due to the elimination of aromadendral during rectification. The oil of the Braidwood variety of *E. australiana* is the best and cheapest disinfecting oil (phenol coefficient=5·8 in 30 minutes). The oil of *E. cinerifolia* was the second best crude oil tested (phenol coefficient=4·8 in 30 minutes); its activity is probably due to its aromadendral content. As in the case of phenol, the addition of acid to the water used in emulsifving the oils greatly increases the germicidal activity.—T. **Steel**: Water from the roots of the red mallee. A chemical investigation of water from the roots of this plant from Fowler's Bay, South Australia.—Prof. E. D. **Merrill**: The identity of *Polypodium spinulosum*, Burm. f. The author, by comparing Burman's figure with Australian material, concludes that the plant described as *P. spinulosum* from Java represents the W. Australian plant, *Synaphea polymorpha*, R. Br., and that the locality record is an error.

BOOKS RECEIVED.

Physiology and Biochemistry in Modern Medicine. By Prof. J. J. R. Macleod. Assisted by Dr. Roy D. Pearce and by others. Pp. xxxii+903. (London: Henry Kimpton, 1919.) 36*s.* net.

The Conditions that Govern Staleness in Bread: Changes of Moisture and Soluble Extract with Age. Investigations and Researches made in the British Army Bakeries in France, 1917–18. By Capt. R. Whymper. (Reprinted from the *British Baker*.) Pp. 72. (London: Maclaren and Sons, Ltd., 1919.) 1*s.*

Board of Agriculture and Fisheries. Fishery Investigations. Series iii. Hydrography. Vol. i. The English Channel. Part i.: Start Point to the Channel Islands. Review of the physical and chemical properties of the surface waters, and the variations of these properties during the thirteen years from 1904 to 1917 inclusive. (London: H.M.S.O., 1919.) 10*s.* net.

Some Questions of Phonetic Theory. By Wilfrid Perrett. Chap. v.: The Perception of Sound. Pp. 39. (Cambridge: W. Heffer and Sons, Ltd., 1919.) 2*s.* net.

The Silk Industry and Trade: A Study in the Economic Organisation of the Export Trade of Kashmir and Indian Silks, with special reference to their Utilisation in the British and French Markets. By Ratan C. Rawlley. Pp. xvi+172. (London: P. S. King and Son, Ltd., 1919.) 10*s.* 6*d.* net.

We Must Discover. Pp. viii+176. (London: Simpkin, Marshall, Hamilton, Kent, and Co., Ltd., 1919.) 3*s.* 6*d.* net.

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